AD 654560

Report 2337

DEPARTMENT OF THE NAVY

HYDROMECHANICS

o

AERODYNAMICS

o

STRUCTURAL MECHANICS

o

APPLIED MATHEMATICS

o

ACOUSTICS AND VIBRATION

# NAVY AUTOMATED RESEARCH AND DEVELOPMENT INFORMATION SYSTEM (NARDIS) PROGRESS REPORT, JULY 1966

by

Gilbert R. Gray, Thomas A. Duckenfield,
and Joseph L. Fuchs

Distribution of this document is unlimited

APPLIED MATHEMATICS LABORATORY
RESEARCH AND DEVELOPMENT REPORT

August 1966 Report 2337

D D C
RECEIVED
JUL 13 1967
B

ARCHIVE COPY

DAVID TAYLOR MODEL BASIN
WASHINGTON, D. C. 20007

# NAVY AUTOMATED RESEARCH AND DEVELOPMENT INFORMATION SYSTEM (NARDIS)

PROGRESS REPORT, JULY 1966

by

Gilbert R. Gray, Thomas A. Duckenfield,
and Joseph L. Fuchs

Distribution of this document is unlimited

August 1966

Report 2337
R-F099 88 01

## FOREWORD

Throughout the national scientific community, a serious "information gap" exists between the time scientific efforts are funded and commenced to the time they are either completed or have reached a milestone that results in a technical report. NARDIS (Navy Automated Research and Development Information System) is an attempt to fill this gap for Navy-sponsored research and development. This report is a summary of NARDIS operations for fiscal year 1966 during which time over 500 requests (amounting to nearly 800 queries) were processed; the R&D data bank was doubled; and new responsibilities were assigned.

During the period covered by this report, the present U.S. Navy Systems Commands were organized from Bureaus or parts of Bureaus. For that reason, the statistics are given in terms of the old Bureaus.

TABLE OF CONTENTS


| | Page |
|---|---|
| ABSTRACT | 1 |
| I. FISCAL YEAR 1966 OPERATIONS | 1 |
| A. The Data Bank | 1 |
| B. The Computer System | 1 |
| C. The User | 3 |
| D. New Responsibilities | 4 |
| E. The Defense Documentation Center (DDC) | 5 |
| F. Operation Manuals | 6 |
| II. PROBLEM AREAS | 6 |
| A. Keypunching | 7 |
| B. Input | 7 |
| C. Output | 9 |
| III. FY-66 STATISTICAL TABLES | 10 |
| Table 1 - June 66 Status of NARDIS Data Bank | 10 |
| Table 2 - June 66 Status of NARDIS Data Bank (by Bureau, Command, Office) | 11 |
| Table 3 - Queries by Subject Area | 11 |
| Table 4 - Queries by Organization | 12 |
| Table 5 - User Appraisals | 12 |
| IV. FUTURE DEVELOPMENT | 13 |
| A. New AML Computer System | 13 |
| B. Thesaurus Development | 13 |
| APPENDIX A - NARDIS DESIGN | 14 |
| APPENDIX B - NARDIS DATA REQUEST AND APPROVAL | 25 |
| APPENDIX C - NARDIS USER QUESTIONNAIRE FORM | 28 |

ABSTRACT

This report is a summary of NARDIS (Navy Automated Research and Development Information System) operations for fiscal year 1966. More than 500 requests (amounting to nearly 800 queries) were processed; the R&D data bank was doubled; and new responsibilities were assigned.

# I. FISCAL YEAR 1966 OPERATIONS

## A. THE DATA BANK

The NARDIS data bank has changed in both size and coverage. Non-R&D-funded technical efforts are now being reported along with increased numbers of R&D funded work. A year ago, about 60 percent of the input to the data bank from the field was being received on 20 or more different types of "working papers" (contracts, program summaries, etc.) as opposed to DD 1498 forms. This figure has dropped to about 40 percent. Now, R&D planning documents are included along with the work unit reports.

In June 1965, the data bank consisted of 4000 work units all funded under elements 6.1 (research) or 6.2 (exploratory development). During June 1966 the data bank averaged 8050 research and development resumés. Of these, 6746 were at the work unit level and 1304 were at the planning level. Sixty of the work units were not R&D funded but involved technical research or exploratory development. The status of the data bank as of June 1966 is shown in Table 1. Table 2 shows the same data by Bureau or Command.

The logistics, textual and subject matter files, representing one copy of the digitalized 8050 R&D resumés, require 14 magnetic tapes. With the 3 additional reels of the thesaurus file, the total data bank comprises 17 reels.

## B. THE COMPUTER SYSTEM

NARDIS is a series of interrelated programs, modularly structured to ensure maximum flexibility. The discussion that follows is concerned with some of these programs and the modifications which were made to them to improve various aspects of the system, such as searching, retrieving, file maintenance, and document reproduction.

Five subsystems constitute the essential elements in NARDIS. These subsystems are the Management Data Search, Subject Matter Search, Thesaurus, Report Generation, and File Maintenance. Of these subsystems, substantial changes were made to the Subject Matter Search and File Maintenance subsystems. The motive for these changes was to reduce the search time. This required a totally different orientation of file structure and manipulation.

1. Subject Matter Search and File Maintenance Subsystems

Originally, NARDIS subject matter search technique was based on a linearly structured file. That is, the file was sequenced by accession number. Terms used to index a document were associated with the document's accession number. As a result, search criteria had to be stored in memory. This imposed a limit on the number of queries that could be processed in one pass of the file. Also, the search time tended to increase almost exponentially with an increase in queries.

NARDIS experience with these limitations verifies the experience of others that both linear and inverted search capabilities are desirable. In regard to the inverted search capability, two benefits were discerned. First, the system could process any finite number of search criteria in one pass of the file; and second, search time would be reduced if many queries were involved. On the strength of these benefits, the inverted file philosophy was adopted. The necessary subsystem to process an inverted file was designed and programmed.

2. Management Data Search Subsystem

A new capability has been added to this subsystem so that the search program may update as well as search and retrieve. This feature is invaluable for making small changes to the management data file which otherwise would have to be made via the regular file maintenance subsystem. It is stressed that this capability must be used judiciously and in a controlled environment.

3. Retrieval Tools

Increased system responsiveness is a constant factor that stimulates the creation of retrieval aids for the indexer. The coordinate index typifies the kind of retrieval aids that have evolved over the past year. Its primary purpose is to provide a means for answering simpler subject matter queries.

The basic feature of the NARDIS coordinate index is that it consists of a maximum of three terms in combination which have been used to index a single intellectual concept found in a document. This combination of terms may have been used in any number of documents and accordingly the accession number of each document accompanies the coordinated terms. In addition, the coordinated terms are so processed as to make available all possible permutations. The coordinate index is sequenced by a primary term (the first term in the combination), coordinate terms, and an accession number. As a retrieval aid, the coordinate index may be used to satisfy many queries without having to use the computer.

4. Document Reproduction

One of the essentials of a responsive information system is its capacity to communicate to the user the information obtained as the result of a search of the data bank. NARDIS has the following data and document reproduction capability:

a. Listings generated by the computer.

b. DD 1498's reproduced from microfilm.

c. DD 1498M's generated by the computer.

d. Aperture cards.

e. DD 1498 images on tape or facsimiles thereof.

Statistics based on the NARDIS first year of operation indicate that approximately 90 percent of the users querying the data bank requested hard copies of the DD 1498M's. Generating DD 1498M's and supplements via the computer has become the rule rather than the exception. It is much easier and less time consuming to reproduce hundreds of documents via the computer rather than to reproduce them by semi-automatic or manual methods. Nevertheless, there are problem areas associated with computer-generated document reproduction and they are discussed in Section II. C.

## C. THE USER

In many cases the NARDIS user is also one who furnishes input and updates to the data bank. Some of the reasons given for using the data bank include:

1. To monitor programs and projects.

2. To maintain data, indexes, summaries, etc. on Bureau, Command, and Laboratory R&D for local management purposes.

3. To locate R&D capabilities.

4. To answer questions from higher authority within and outside the Navy.

5. To keep abreast of technical fields.

6. To control the quality of DD 1498's.

7. To discover approaches for solving assigned problems.

For purposes of local NARDIS operations, a query is placed into one of two categories, depending on whether it is primarily (1) a management-oriented question with little (if any) subject matter content thus requiring the logistics search procedures; or (2) a subject-matter-oriented question requiring a subject matter search procedure.

Over 500 requests have been received. Since users often write many different questions on the same form, the number of actual queries amounted to over 800. Tables 3, 4, and 5 in Section III summarize respectively the type of questions asked; the user organization for which the questions were asked; and the evaluations by the users of the replies obtained.

## D. NEW RESPONSIBILITIES

NARDIS growth during its first year of operation was marked by the assumption of two additional areas of responsibility which encompassed: (1) processing of the Navy R&D planning documents; and (2) developing the Ocean Center R&D Information System. The former came as a natural sequel to the development and expansion of NARDIS. This can best be explained by pointing out that work units represent the translation of R&D plans into research and exploratory efforts. In general, the work unit contains most of the data elements on the planning documents.

The major advantage to be realized from the processing of planning documents on the computer is that once the document has been entered into the system, the originator needs only to indicate those data elements which changed since the document was last submitted to NARDIS. Prior to each submission period, NARDIS provides the originator with a copy of his planning document which he updates and returns to NARDIS. Currently, NARDIS is processing and preparing the planning documents for submission to Office of Director of Defense Research and Engineering (ODDR&E) for the second time. The end product will be an aggregation of approximately 1200

R&D planning documents generated into element sets and sequenced in a prescribed manner on the LARC computer. In essence, NARDIS serves as the central agency for processing the Navy's R&D planning documents, compiling them, and submitting them to a designated printer for printing and distribution.

The Navy Ocean Center was established as part of the Navy Oceanographic Office by CNO to serve as DOD's link in the federal chain of information centers on oceanography. In late fiscal year 1966, NARDIS was officially assigned the task of supporting the Navy Ocean Center Staff in those areas related to R&D in oceanography.

The Ocean Center R&D Information System has advanced to the point where a glossary on oceanography has been compiled; a subject matter search and maintenance system has been established; a subject matter file has been created; and a set of retrieval tools (Usage Table, Linear Subject Matter Index, etc.) has been made available. By and large, the Ocean Center System, both in structure and operations, parallels NARDIS. Many of the programs used in the NARDIS operation have been adapted for the Ocean Center. The Ocean Center Glossary is a compilation of subsets of terms from the NARDIS Thesaurus and three oceanographic term lists. These are the Glossary of Ocean Science and Undersea Technology Terms by L.M. Hunt and D.G. Groves, the Glossary of Oceanographic Terms by B.B. Baker, and the Oceanic Coordinate Index of the Mission Bay Oceanic Library. The Ocean Center Glossary does differ from the NARDIS Thesaurus in that it is not as highly structured. Another difference is that the Ocean Center subject matter indexing does not include roles and links.

## E. THE DEFENSE DOCUMENTATION CENTER (DDC)

DDC is the hub of the Department of Defense (DOD) research and development Work Unit Data Bank. The Navy is one of its high volume contributors. The NARDIS data bank is an expansion of the data submitted to DDC, in that (1) it includes more data elements for each resume; (2) it includes work units from funding areas other than elements 6.1 and 6.2; and (3) it includes planning documents.

DDC is responsible for (1) maintenance of the work unit data bank; (2) preparation of reports from the data bank to users' specifications;

(3) maintenance of a procedures manual; and (4) implementing and monitoring the system to ensure uniformity and compliance.

A DD 1498 working group has been in operation during the past year. Its purpose is to identify and solve problems relating to the DD 1498 system. A procedures manual subpanel has hammered out a draft manual which has been forwarded to DDR&E (Director of Defense Research and Engineering) for comment. When issued, this manual will be the major instruction for use by all contributors to the work unit data bank.

F. OPERATION MANUALS

A series of operation manuals, setting forth the general procedures, systems design, and operating instructions for major NARDIS subsystems were either written or started during FY-66. Primarily, these manuals are intended as compact information packages for NARDIS personnel. For that reason, they are written as Applied Mathematics Laboratory Technical Notes and, hence, the external distribution is limited and controlled by the Head, Applied Mathematics Laboratory, David Taylor Model Basin.

Operation manuals have been (or will be) written to cover the following areas:

1. Subject Matter File Maintenance (completed)
2. Subject Matter Search System (completed)
3. Thesaurus Maintenance and Use (started)
4. Management Oriented Search System (started)
5. Report Generator (started)
6. DD 1498 File Maintenance (started)

## II. PROBLEM AREAS

As would be expected, a variety of problems were experienced in FY-66. These problems were intensified by the fact that (1) the Navy was in the process of a major reorganization; (2) the planning level resumés, representing 16 percent of the data bank, require 33 percent of the computer file maintenance processing time (due to more frequent updates and requirements for output); (3) the competitive market for personnel skilled in data processing, programming and information processing has been

tight; and (4) some R&D data elements (release limitation, organization type, etc.) were slow in being clarified by appropriate authority. In the discussions that follow, only the major lingering problems are mentioned.

## A. KEYPUNCHING

NARDIS keypunching is characterized by the large volume of cards involved and the variety of complex data elements that have to be punched. Steps taken early in FY-66 to alleviate the keypunching problems experienced in FY-65 proved fruitful only during the first few months of FY-66. Later, long delays in the digitalizing process occurred. These problems resulted, first, from the high turnover rate among the NARDIS keypunch contractor's personnel and, second, from his loss of 9 keypunch operators in a 2-week period.

To meet this situation, a new supplemental contract was used. The ultimate solution to the problem, however, points toward the use of an optical reader or typewriter-to-magnetic-tape equipment. Either of these devices should cost less than keypunching, require just one "keying" of the data, end the requirement for extensive proofreading, and save considerable time while maintaining reliability.

## B. INPUT

Input to NARDIS has been of varying format and correctness, with some improvements noted during the year.

### 1. Format

From the beginning, so as not to place additional work loads on contributors to the system, NARDIS agreed to accept nonstandardized input. As a result, material was received in such various formats as PR (Procurement Request), PJ (Project Justification), MIPR (Military Interdepartmental Purchase Request), IPR (Interdepartmental Purchase Request), contract papers and/or amendments. This lack of standardization, omission, or unclearness of data elements led to serious input problems. Progress is being made in securing the assistance of the reporting Systems Commands, Bureaus, and Offices to further standardize the input to NARDIS.

2. Contracts

The data bank is estimated to contain in excess of 80 percent of the reportable R&D in elements 6.1 and 6.2. Contracts awarded by some of the Systems Commands, however, represent a major gap. Currently awarded contracts are sometimes reported, but those already in progress are not represented in the data bank due to a total lack of input, or to excessively incomplete submissions.

3. Update

Each report contained in the data bank is required to be updated whenever a significant change occurs, or at least once a year to revise the fiscal year dates and resources estimates. NARDIS is supplying some Bureaus and Offices, when agreeable to them, with machine-produced DD 1498M's and TMB 952M's to be used as a basis for updating. Other Navy units, to date, are not following this procedure. Thus, their updates are not identified by the Agency Accession Number (serial number) causing further matching complications. Still other updates received are incorrectly identified, for instance, not distinguishing between a completed work unit (in-house or contract) (Code B) and one which has been terminated (Code C) prior to running its expected course. This naturally leads to incorrect information for Navy and DOD. In each case, these problems have been brought to the attention of the cognizant Navy unit for appropriate action.

4. Source of Funds

Many reports indicate Navy as the source of their R&D funds, or omit this data element entry and let it be assumed as Navy. Actually, the Navy performs considerable research funded by DASA (Defense Atomic Support Agency), NASA (National Aeronautics and Space Administration), Army, Marine Corps, etc. When these agencies request a report from NARDIS of the work they are funding, the output is often very incomplete, since the original source of funds was not identified on input.

5. Problem Data Elements

Much discussion has been held concerning release limitations. There have been wide discrepancies in their use, overuse, and in the assignment of inappropriate combinations. Currently, meetings are being held to clarify the situation. Another area of concern is the organization

type code. The current list has been found in practice to be overly detailed and lacking in sufficiently clear definitions to enable a person completing the DD 1498 to assign the correct type code. A committee is to be formed under the DD 1498 Working Group at DDC to provide a simpler coding system suitable for centralized and automatic assignment.

6. Workshop

A 2-hour workshop is being prepared, to be given at the laboratory and project manager level, to correct most of the preceding problems. This workshop, in conjunction with the forthcoming DDC Work Unit Data Bank Procedures Manual, should do much to enhance the quality of NARDIS input.

C. OUTPUT

A significant problem confronting NARDIS today is its inability to provide multicopies of documents. This is not to say that NARDIS desires to be in the printing business, but rather to point out an area closely allied with communicating results to the user of the NARDIS system. Often the user of the system desires more than a single copy of a document which satisfies his query. In attempting to satisfy this request, NARDIS finds it necessary to delay the responses to a query until the documents have been printed. By now, the turn-around time of 72 hours has been severely affected. With increased use of NARDIS, it can be anticipated that this problem will become more acute.

Several ideas are in formulation. One involves the extension of the computer system to provide a capability for generating multicopies of a given document on the computer. This approach makes only a small dent in the problem because the present hardware (printer) can print at most approximately 400 NARDIS documents an hour. In addition, the hardware is shared with other projects. Another approach involves the use of a microfilm device coupled to the computer. This approach is in the investigative stage and must be viewed in connection with the acquisition of a new computer by the Applied Mathematics Laboratory.

The use of multicopy paper has also been considered. The problem here is that the quality of the print degenerates rapidly when more than

three carbon copies are made. Coupled with this is the fact that often the request is for 10-20 copies of a single document. Thus, multicopy paper only partially alleviates the problem.

## III. FY-66 STATISTICAL TABLES

The tables in this section summarize the status and use of the NARDIS data bank. The statistics are compiled from the data bank itself, the query forms, and the user questionnaire forms. The query form (see Appendix B) is the official vehicle by which the user asks his question(s), establishes his security clearance, verifies his need to know, and affirms his intended distribution of the output. During FY-66, two user questionnaire forms (see Appendix C) were used at different times. The later form was intended to further improve communications between NARDIS and the user by distinguishing between output that is relevant to the topic of the search and output that is actually useful to the purposes of the user. The questionnaire form is intended to make it convenient for the user to communicate his evaluation, suggestions, protests, utilization, etc. of the output received.

Currently, both the query and user questionnaire forms are undergoing changes intended to improve their usefulness. Emphasis is being put on the human engineering of the forms and the collection of additional vital information.

TABLE 1

June 66 Status of NARDIS Data Bank

| Element | Work Units | Planning | Total |
|---|---|---|---|
| Research (6.1) | 3412 | 131 | 3543 |
| Exploratory Development (6.2) | 2976 | 1009 | 3985 |
| Systems | 298 | 164 | 462 |
| Non-R&D-Funded | 60 | 0 | 60 |
| Total | 6746 | 1304 | 8050 |

TABLE 2

June 66 Status of NARDIS Data Bank (by Bureau, Command, Office)

| Organization | 6.1 Element | | 6.2 Element | | Systems | | Other | | Total | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | W/U* | Plan | W/U | Plan | W/U | Plan | W/U | Plan | W/U | Plan | |
| BUDOCKS | 61 | 4 | 180 | 74 | -- | -- | -- | -- | 241 | 78 | Now NAVFACENGCOM |
| BUMED | 302 | 13 | 134 | 21 | -- | -- | -- | -- | 436 | 34 | |
| BUPERS | -- | -- | 103 | 65 | -- | -- | -- | -- | 103 | 65 | |
| BUSANDA | -- | -- | 94 | 40 | -- | -- | -- | -- | 94 | 40 | Now NAVSUPSYSCOM |
| BUSHIPS | 146 | 15 | 966 | 315 | 246 | 43 | 60 | -- | 1412 | 373 | Now divided into NAVSHIPSYSCOM and NAVELECSYSCOM |
| BUWEPS | 195 | 19 | 1050 | 342 | 42 | 92 | -- | -- | 1287 | 453 | Now divided into NAVAIRSYSCOM and NAVORDSYSCOM |
| MARINE CORPS | -- | -- | 9 | 64 | -- | 25 | -- | -- | 9 | 39 | |
| OBSERVATORY | -- | 2 | 14 | 4 | -- | -- | -- | -- | 14 | 6 | |
| OCEANO | 8 | -- | 35 | 21 | 2 | 4 | -- | -- | 45 | 25 | |
| ONR | 2700 | 78 | 397 | 63 | 8 | -- | -- | -- | 3105 | 141 | |
| Total | 3412 | 131 | 2976 | 1009 | 298 | 164 | 60 | -- | 6746 | 1304 | |
| | | | | | | | | | 8050 | | |

*W/U = Work Units

TABLE 3

Queries by Subject Area

| Broad Subject Area | Number of Requests | Percentage (approx) | Broad Subject Area | Number of Requests | Percentage (approx) |
|---|---|---|---|---|---|
| Materials: Including coatings, corrosion, etc. | 37 | 7.3 | Hydromechanics: Including ship design, ship motion, etc. | 15 | 3.0 |
| Computers: Including cybernetics, programming, information systems, etc. | 31 | 6.1 | Lasers | 13 | 2.5 |
| | | | ASW | 12 | 2.3 |
| Electronic Warfare | 26 | 5.1 | Nuclear Research | 12 | 2.3 |
| Power Generation: Including batteries, propulsion, fuel cells, etc. | 22 | 4.3 | Satellites/Missiles | 12 | 2.3 |
| | | | Reliability/Maintainability | 11 | 2.1 |
| Explosives: Including weapon effects, armor ballistics, etc. | 20 | 4.0 | Oceanography | 11 | 2.1 |
| | | | Navigation | 11 | 2.1 |
| | | | Meteorology | 11 | 2.1 |
| Medicine: Including biology, animal studies, diseases, etc. | 20 | 4.0 | Social Sciences | 11 | 2.1 |
| | | | Communication | 10 | 2.0 |
| | | | Optics | 10 | 2.0 |
| Acoustics: Including ship silencing, sonar, etc. | 19 | 3.7 | Others | 192 | 38.0 |
| | | | Total | 506 | 100 |

TABLE 4

Queries by Organization

| Organization | Number of Queries | Organization | Number of Queries |
|---|---|---|---|
| ONR (HQ) | 74 | ASW PROJECT OFFICE | 6 |
| ARMY | 49 | NEL | 6 |
| NRL | 44 | BUSANDA | 5 |
| BUSHIPS (HQ) | 29 | NCEL | 5 |
| NASL | 29 | NOTS | 5 |
| DTMB | 28 | NUSL | 5 |
| MEL | 26 | BUMED | 4 |
| NWL | 24 | DDR&E | 4 |
| BUWEPS (HQ) | 23 | ONM | 4 |
| CNO | 21 | NADC | 3 |
| CNM | 19 | NSG | 3 |
| BUDOCKS | 17 | NAVCOSSACT | 2 |
| OCEANO | 14 | NTDC | 2 |
| AIR FORCE | 9 | ARPA | 1 |
| NMDL | 9 | DASA | 1 |
| NRDL | 9 | DCA | 1 |
| BUPERS | 8 | DIA | 1 |
| NAEC | 7 | OBSERVATORY | 1 |
| NOL | 7 | | |
| | | Total | 506 |

TABLE 5

User Appraisals

| Type of Appraisal | Number of Appraisals | Percentage (approx) |
|---|---|---|
| Subject Matter Queries | 60 | 82.1 |
| Management-Oriented Queries | 13 | 17.9 |
| Total Number of Appraisals Received | 73 | 100.0 |
| Average Relevance of Subject Matter Queries | 60 | 58.2 |
| Average Relevance of Management Queries | 13 | 100.0 |
| Average Relevance for All Queries | 73 | 65.6 |
| Uses of NARDIS Output: | | |
| (1) Monitor Program | 32 | 43.8 |
| (2) Avoid Duplications | 26 | 35.6 |
| (3) Locate Capability | 7 | 9.6 |
| (4) Other | 8 | 11.0 |
| Satisfactory Response Time | 68 | 93.1 |
| Unsatisfactory Response Time | 5 | 6.9 |
| Significant Contribution to User | 63 | 86.3 |
| Insignificant Contribution to User | 10 | 13.7 |

## IV. FUTURE DEVELOPMENT

### A. NEW AML COMPUTER SYSTEM

The Applied Mathematics Laboratory, David Taylor Model Basin, is currently preparing to acquire a new computer system. Some of the features of this system will have a great impact on the operational end of NARDIS, and other features will have an equal impact on both NARDIS operational people and the users. Some of these features are real time, remote control, time sharing, and mass storage capabilities. During FY-67, much of the spade work, necessary to prepare NARDIS and its users for the new system, will be started.

### B. THESAURUS DEVELOPMENT

The ultimate aim of NARDIS thesaurus development is the creation of a unique Navy-wide controlled vocabulary which reflects all the areas of current Navy research and development, and which relates the degree of specificity of the terms in a given research area to the importance the Navy assigns to that area. The format and development of these terms will continue to follow the conventions promulgated by Project LEX. Thus, the NARDIS thesaurus will be compatible with the LEX thesaurus, but will also contain additional terms which are specific to Navy research.

Continual editing and weekly updating of the thesaurus will keep the thesaurus flexible and representative of current research as reported on the DD 1498 forms. Both existing terms and suggested new terms are evaluated for technical accuracy, obsolesence, general acceptance and usage by investigators, nonduplication of concepts already in the thesaurus, and potential usefulness in NARDIS. Term formats are being standardized in anticipation of semiautomatic indexing trials. Changes in the thesaurus update computer programs are being studied in an attempt to reduce time requirements, manual effort, and the margin of human error. Automatic generation of reciprocal generic transactions is among the ideas being considered to more completely utilize computer capabilities.

Since the best thesaurus is merely the best tool for accurately indexing and retrieving information by subject matter, future developments will continue to be evaluated for their contribution to the NARDIS system as a whole.

# APPENDIX A
# NARDIS DESIGN

## OUTLINE APPENDIX A

I. OBJECTIVES
   A. Navy Requirements
   B. DOD Requirements

II. PHILOSOPHY
   A. User Orientation
   B. Computer Orientation

III. DATA BANK
   A. Management-Oriented File
   B. Textual File
   C. Subject Matter File
   D. Microfilm File
   E. Thesaurus File

IV. COMPUTER SYSTEM
   A. File Maintenance
   B. Management Searches
   C. Subject Matter Searches
   D. Report Generator
   E. Outputs

V. SEARCH STRATEGY
   A. Indexing Scheme
   B. Query Processing
   C. Query Indexing Tools
   D. Thesaurus Use and Development
   E. Automatic Generic Posting

## I. OBJECTIVES

### A. Navy Requirements

The basic objective of NARDIS is to establish and maintain a common data bank of scientific, technical, and administrative information on all Navy-sponsored research and development. This data bank may be used as a prime source of RDT&E information by all military, management, scientific, and technical echelons of the Navy.

### B. DOD Requirements

NARDIS also has the responsibility of meeting the Department of Defense requirements (DOD Instruction 7720.13 of 27 January 1965) that all Navy research and development at the work unit level be reported digitally to ODDR&E (Office of the Director of Defense Research and Engineering) via DDC (Defense Documentation Center).

## II. PHILOSOPHY

### A. User Orientation

In many cases, the user will also be the person or organization responsible for furnishing NARDIS with its basic RDT&E data. To relieve the user from many burdensome and clerical tasks, the NARDIS staff has assumed as much of the reporting responsibility as possible. However, the responsible investigator must furnish all of the technical inputs. The use of NARDIS storage and retrieval service in no way requires familiarity with the details of the computer system or program.

### B. Computer Orientation

An effective and responsive information system depends on the quality of the input making up its data bank, the timeliness of responses to its queries, the accuracy of its output, and the currentness of its data files. To optimize these factors within the framework of its mission and funds, NARDIS has as its core, the UNIVAC LARC computer. The computer is used in all file development and maintenance; in administrative and technical searches; in all reporting; and in checking manual operations

for consistency and quality control. The one area in which the computer does not play a dominant role, is in subject matter indexing, which is assigned to physical scientists and technical librarians.

## III. DATA BANK

The NARDIS data bank is a composite of interrelated files which form the data nucleus for the system. These files are the Management-Oriented File (LOG), Textual File (TEXT), Subject Matter File (SUB), Microfilm File (MICRO), Thesaurus File (THES), and the User Interest File (USER). Except for the Microfilm File (MICRO), the files are maintained on magnetic tape.

### A. Management-Oriented File

The management oriented file has been structured and generated to carry all of the information reported on the Research and Technology Resumé (DD 1498) and NARDIS RDT&E Supplement (NDW-TMB-952), except for the textual information. This file is used for management searches as well as coordinated searches (a combination of management and subject matter searches).

### B. Textual File

In terms of physical size (number of tapes), the textual file has a 3:1 ratio to the management-oriented File. That is, for every accession number appearing on the LOG file, there are, on the average, three corresponding and related text segments.

### C. Subject Matter File

This file results from the subject matter indexing of scientific and intellectual concepts contained in the statement of the objective, approach, progress, etc. of R&D resumés. Coordinated by roles and links, SUB is the primary reference tool for subject matter retrieval.

### D. Microfilm File

In response to the microfilm requirement stipulated for NARDIS, a microfilm subsystem has been established which utilizes the aperture card

concept. The aperture card concept was the most feasible microfilm approach for NARDIS because of the manner in which the aperture card facilitates updating. The microfilm file serves chiefly as a backup file and as a source from which R&D resumés can be easily and economically reproduced for dissemination.

E. Thesaurus File

Basic to any subject matter information retrieval system is a controlled vocabulary. For NARDIS, a thesaurus has been developed which is the result of a coordinated merge of the Engineers Joint Council and the Bureau of Ships thesauri. This file is used as a guide for indexing resumés and as a source for automatic generic searches. Approximately 80 percent of the terms in the thesaurus are in the engineering category. The remaining 20 percent cover the other intellectual endeavors pursued by the Navy.

## IV. COMPUTER SYSTEM

As mentioned earlier, at the core of NARDIS is the UNIVAC LARC computer which is used for file maintenance, management, and subject matter searches. The basic computer system for NARDIS is operational and available for production.

A. File Maintenance

For purposes of providing the Navy with timely information on its R&D efforts, NARDIS has structured a well-defined maintenance system for each file comprising the data bank. Incorporated in the file maintenance are the following main features:

1. Capability to delete, add, or replace a link or any descriptor-role within the link on the subject matter file;

2. Capability to delete, add, or replace a given LOG data unit or a TEXT segment associated with a given R&D effort;

3. Capability to delete, add, or replace a term in the thesaurus file; and

4. Capability to update any document in the microfilm file without affecting any of the other documents.

The computer is also used to make extensive checks for accuracy and consistency before data is entered into the data bank. Query parameters to the system are also checked in this manner.

B. Management Searches

One of the salient features of NARDIS is its management-oriented search capability which permits the selection of R&D resumés on the basis of technical, fiscal, and managerial questions raised by Navy scientific and management personnel. Searches may be made on equality, inequality, or ranges. Additional features include the capabilities to search on partial and segmented fields. A partial field search involves searching on a specific portion of the field and ignoring the remainder of the field. A segmented key involves processing subfields within a field.

Input requirements for the management search subsystem are the management-oriented file and the query parameters.

C. Subject Matter Searches

The subject matter search subsystem provides generic search capability. Very briefly, a generic search involves furnishing all generic terms for a given term provided the "supply generic term option" is specified on the query parameter. Subsequently, the generic terms chosen, are used to search the subject matter file. Those documents on the file satisfying the query are selected from the LOG file and are made available for further processing.

D. Report Generator

The report generator is the means by which the results of a query can be communicated to the requester in a suitable format. Since the required output format for each query response will vary, the report generator has incorporated features that give it this versatility. These features allow a maximum of three, 120-word lines of edited information, 101 processable fields, and accumulations on about 15 keys. The format of a report is conveyed to the report generator via a parameter card. It is important to note that the user does <u>not</u> have to detail the parameters for the report generator other than to indicate, in his vernacular, what

data elements he would like to see, the sequence, type of totals, etc. Ninety percent of the output requirements of NARDIS are answered by the report generator.

### E. Outputs

NARDIS has the facility to provide outputs in the form of report summaries, aperture cards, R&D resumés, or magnetic tape. Report summaries are made available through the report generator which can provide summaries according to the wishes of an individual. Copies of R&D resumés and aperture cards are available upon request. As for magnetic tapes, NARDIS currently provides DDC card images on magnetic tape.

## V. SEARCH STRATEGY

Search strategy denotes the totality of operations and facilities required to initiate and complete a NARDIS subject matter or data search. A search requires query indexing, keypunching, card-to-tape, and digital computing facilities. For the latter, the current R&D subject matter, logistics, and thesaurus files are required. A search further requires coordination between the indexing of the R&D abstracts and the indexing of the specific query.

### A. Indexing Scheme

To retrieve ideas and concepts requires careful and authoritative preprocessing of textual data. The state-of-the-art is such that no method (automatic or manual) can guarantee anywhere near 100-percent accuracy on a voluminous and/or open-ended data bank. A wide range of workable schemes involves the use of coordinate indexing.

The objective, approach, and progress (if any) as well as the prior and future efforts and references are available from research tasks as a source for technical indexing. Generally, these text segments run one paragraph each. Indexing from this text involves (1) formulating the discrete ideas or concepts presented, (2) selecting terms (or descriptors) from a controlled source, and (3) relating the selected terms in "some syntactical sense" so that false concepts are not implied. The value of subsequent searches is basically dependent on the quality and diligence of initial indexing.

The Engineers Joint Council (EJC) system of roles and links has been adapted by NARDIS as its initial technical indexing scheme. The "syntactical sense" of the selected terms are pinpointed by (1) links which group together terms belonging to one concept and (2) roles which tag the terms as to their function or use within the links. (See Figure 1 for role definitions.)

The EJC system is not free of indexing problems related to consistency. Just as one may express a single idea with many different sentences using different combinations of words, so can one "correctly" index a document using many different link and role combinations. Inconsistency in role assignments also occurs. The nonexistence of a small set of "universal roles" for coordinate terms and the fact that roles show the function of terms in a link, not the interrelation between terms, are related to this problem. This existence of several "correct" indexes for a document or concept often plagues later retrieval. Clearly, the effective use of the EJC system requires adept subject-oriented indexers and an adequately controlled thesaurus.

B. Query Processing

Subject matter searching is information retrieval as opposed to data retrieval in the sense that there must be some understanding on the part of the searcher (1) of the information desired and (2) of the total system being used to make the search. In the latter case, the understanding required centers around the system's approach (and its accuracy and limitations) in simulating the structure of knowledge.

NARDIS searches are accomplished by indexing each question in the same manner as the technical data bank is indexed, i.e., the EJC system. Once a question is prepared for the computer it is referred to as a "query." A single question, after indexing, may result in several "queries," each one of which would be designed either to answer part of the question or to answer the same question with a different strategy. Hence, there is an attempt to duplicate original indexing while processing questions.

As mentioned earlier, the original document may have been indexed in one of several different "correct" or acceptable ways. To cope with

| ROLE NUMBER | DESCRIPTION |
|---|---|
| 8 | Primary topics; principal subjects |
| 1 | Inputs |
| 2 | Outputs |
| 3 | Undesirables; unnecessaries |
| 4 | Present, possible, and later uses |
| 5 | Media; adverbs; adjectives; geographic locations |
| 6 | Independent variables; causes |
| 7 | Dependent variables; effects |
| 9 | Passive recipients; location |
| 10 | Means of accomplishment |

Figure 1 - Role Definitions

this situation, four different principles are applied to indexing queries:

1. Subject Expert - use the services of subject matter experts to ensure understanding of the technical question.

2. Different Strategies - use alternative indexing approaches to increase chances of matching original indexing.

3. "Broad Indexing" - use indexing strategies designed to earmark and select related documents.

4. Search Tools - use the various NARDIS search tools as guides or leads to appropriate search strategies.

C. Query Indexing Tools

NARDIS search tools include the following:

1. NARDIS Thesaurus - a guide to legitimate terms and their interrelationships.

2. Usage Table - a list and role analysis of all the terms actually used in indexing.

3. Coordinate Table - a list of coordinate concepts and the number of times they appear in sets in the subject matter file.

4. Generic Help - the option of indexers to ask the computer to augment the indexing by adding related, narrower, and/or broader terms.

5. Linear Subject Matter Index - a listing of each document followed by the links, roles, and terms used in its indexing.

6. Inverted Subject Matter Index - a listing of each term followed by the documents, links, and roles to which the term has been posted.

7. Inverted and Linear Keyword Indexes - inverted and linear listings of search and index terms suggested by the responsible scientist.

D. Thesaurus Use and Development

The NARDIS Thesaurus was initially assembled by a computer merge of the Engineers Joint Council's Thesaurus of Engineering Terms, with 10,500 terms (1st ed., 1964), and the Bureau of Ships Thesaurus of Descriptive Terms, with 4,700 terms (2nd ed., 1965). The first thesaurus contributed the necessary engineering terminology, and the second

supplied terms specific to the Navy. However, since Navy research and development embraces a very broad span of knowledge, the NARDIS Thesaurus will remain open-ended, allowing for the addition of terms in all areas, as required.

The NARDIS Thesaurus serves a dual function. It is first a guide to technical terms, their synonyms, and their hierarchical relationships. In this capacity, it is an indexing tool both for storage and retrieval, containing also its own code book. The Thesaurus serves secondly as an efficient means for vocabulary control, so important in a computer-oriented system. The Thesaurus resolves questions as to proper spelling, and term meaning.

The relationships of terms shown in the Thesaurus are of three types: Synonymous, Hierarchical, and General. They are designated as use-includes, broader-narrower, and related, in that order.

E. Automatic Generic Posting

A resumé is indexed with the most specific terms available in the Thesaurus. Thus a search can retrieve resumés on any specific term. But the capability of the system does not end here. In searching, an option may be exercised by the indexer. He may specify retrieval on one or more terms in a query, and at the same time he may elect to include terms broader, narrower, or related to one or more of the query terms. This is the generic option. Thus by using this option, a general inquiry concerning photography, for example, can be automatically expanded to include the fifteen narrower terms (types of photography) listed under photography in the Thesaurus, with no increase of manual labor. On command, the computer generates the queries for the narrower terms, assigns each a query-part number, and supplies the answers to each. The same applies to broader and related terms. This option is particularly convenient to use in response to "all about" questions.

# APPENDIX B

# NARDIS DATA REQUEST AND APPROVAL

**NARDIS DATA REQUEST AND APPROVAL**
NAVSO 3920/1 (7-65) 0104-901-4410

*INSTRUCTIONS*

*Retrievable fields in the NRDT&E Program are listed on the reverse. If the desired information is statistical in nature, query should state the required sequence of output; for example: "list all work items in numerical order by project, and alphabetical order by performing organization."*

*Submit original and two copies of each request; for convenience, mail in window envelope.*

DATE

TO: Chief of Naval Research
NARDIS Management (Code 1045)
Main Navy Building, Room 0439
Washington, D. C. 20360

REF: (a) ONRINST 3920.4
(b) NAVY SECURITY MANUAL, CHAPTERS 3 AND 4

Please supply NARDIS Data Bank retrieval service on the following query for NRDT&E information, as outlined in reference (a).

1. QUERY

DELIVER TO (Address)

DESIRED METHOD OF TRANSMITTAL

2. SECURITY RELEASE INFORMATION FOR REQUESTED OUTPUT

| a. HIGHEST DESIRED CLASSIFICATION OF OUTPUT (Definitions in ref. b) | b. INTENDED AVAILABILITY AND DISTRIBUTION | YES | NO | c. IF OUTPUT IS KNOWN TO BE CLASSIFIED AND DISTRIBUTION INCLUDES NO(1), NO(4) AND/OR NO(5), LIST THE SPECIFIC USERS |
|---|---|---|---|---|
| UNCLASSIFIED | (1) DOD ONLY | | | |
| CONFIDENTIAL | (2) U.S. GOV'T. DEPTS OUTSIDE DOD | | | |
| SECRET | (3) U.S. CONTRACTORS | | | |
| RESTRICTED DATA | (4) FOREIGN NATIONALS | | | |
| FORMERLY RESTRICTED DATA | (5) OTHER | | | |
| NOFORN | | | | |

3. IDENTIFICATION OF REQUESTER

Requester (Signature)

DOD SECURITY CLEARANCE

(Print name)
(Position title)
(Activity or Agency and location)

TELEPHONE NO

4. AGENCY APPROVAL

AUTHORIZED NARDIS REPRESENTATIVE (Signature)

(Print name)
(Organization title)

THIS SPACE FOR USE BY NARDIS

| NARDIS REQUEST NO. | ACTION | DATE | TIME | INITIALS |
|---|---|---|---|---|
| REMARKS | RECEIVED AT ONR (CODE 1045) | | | |
| | RECEIVED AT DIMB (CODE 880) | | | |
| | INDEXED FOR COMPUTER | | | |
| | OUTPUT TRANSMITTED TO ONR | | | |
| | OUTPUT TRANSMITTED TO REQUESTER | | | |

S-P0007



Best Available Copy

## TABLE OF RETRIEVABLE FIELDS

** Agency Accession Number
** Date of Resume
Program Element Number (current)
Program Element Number (prior)
Project Number (current)
Project Number (prior)
Lab Assignment Number (current)
Lab Assignment Number (prior)
Level of Report
Kind of Report
Report Classification
Work Classification
Regrading
Release Limitations
* Date (current number)
* Prior Date
Date of Previous Report
Start Date
Critical Completion Date
Scientific Areas

FY-1 )
FY ) Funding
FY + 1 )

FY Source of Funds
FY-1 Source of Funds
Cumulative to and including FY-1
Method of Funding
Funding Agency
Procurement Method
Predicted Total Cost
Type of Contract
Contract Number
Amount of Contract
Date of Contract
Date Committed
Expected Duration
In-House Contract Information

** Corporate Code )
ZIP Code ) Govt./Lab/
*** Budget Activity ) Installation/
** Geographic Code ) Activity
Organization Code )

** Corporate Code )
ZIP Code )
Type of Business )
** Geographic Code ) Performing
Type of Organization ) Organization
Requesting Agency )
Participation )
Coordination )

SECNAV Designated )
CNM Designated ) Program Managers
Bureau Designated )

FY-1 )
FY ) Man-Years
FY + 1 )

Special Codes
*** Budget Code
*** ASW Code
*** OSD Code
Warfare Code
CNO Classification
*** CNO Monitor
GOR
Special Emphasis
Bureau or Office Number
COMSEC

* These fields do not contain data at the present time.
** NARDIS provides this information.
*** Information obtained from NRDT&E Project Listing.

## APPENDIX C

## NARDIS USER QUESTIONNAIRE FORM

During the first portion of FY-66, NARDIS User Questionnaire Form A was sent with each set of user output. When it became clear that some users interpreted "relevance" as "relevance and actual usefulness to them," Form B was devised. Form C was introduced as a simple, easy to complete form to encourage user feedback.

NARDIS USER QUESTIONNAIRE A

1. What percentage of information received was relevant to your request?
_____ Percent.

2. In your opinion, is there additional on-going Navy effort for which you did not receive information? _____Yes _____No.

3. Would you have preferred information covering a broader or narrower area than that which you received? ___Broader ___Narrower ___Neither.

4. How did you use the information you received?

_____ Monitor a project or program.

_____ Avoid duplication of effort.

_____ Locate capability for performing work.

_____ Other (Specify) _____

5. Has the information made a significant contribution to your requirements?

____ Highly significant ____ Significant

____ Marginally significant ____ Insignificant

6. Was the response time ____ Satisfactory ____Unsatisfactory?

7. What suggestions do you have for improving the services of NARDIS?

8. Request you indicate additional useful items (data elements) which might be included on the NARDIS Supplement to the DD Form 1498.

NARDIS USER QUESTIONNAIRE B

1. _____ documents [ ], listed items [ ] were sent.

   a. How many items received were relevant to the topics or subjects of your query? _____.

   b. How many items were actually useful for your requirements? _____.

2. In your opinion, is there additional on-going Navy effort which you did not receive information? _____ Yes _____ No.

3. Would you have preferred information covering a broader or narrower area than that which you received? _____ Broader _____ Narrower _____ Neither.

4. How did you use the information you received?

   _____ Monitor a project or program.

   _____ Avoid duplication of effort.

   _____ Locate capability for performing work.

   _____ Other (Specify) _____

5. Has the information made a significant contribution to your requirements?

   _____ Highly significant _____ Significant

   _____ Marginally significant _____ Insignificant

6. Was the response time _____ Satisfactory _____ Unsatisfactory?

7. What suggestions do you have for improving the services of NARDIS?

   _____

   _____

   _____

8. Request you indicate additional useful items (data elements) which might be included on the NARDIS Supplement to the DD Form 1498.

   _____

SUBJECT_____ NARDIS QUERY NUMBER _____

REQUESTER _____ _____

Number of Replies _____

NARDIS USER QUESTIONNAIRE C

Relevance & Usefulness

COMMENTS

1. Was the information received generally relevant?
   - ☐ Yes
   - ☐ No

2. What percent of the replies specifically met your requirements?
   - ☐ 0-50
   - ☐ 50-80
   - ☐ 80-100

3. Did any replies contribute very significantly to your requirements?
   - ☐ Yes
   - ☐ No

4. What were your requirements?
   - ☐ Monitor progress
   - ☐ Avoid duplication
   - ☐ Current awareness
   - ☐ Source of new ideas
   - ☐ Background info and data
   - ☐ Locate capability
   - ☐ Other

Completeness

5. Do you know of additional on-going Navy efforts not reported here?
   - ☐ Yes
   - ☐ No

Response Time

6. Was the response time satisfactory?
   - ☐ Yes
   - ☐ No

Nardis Service

7. What further services might Nardis provide?

Subject _____ Date Received _____

NARDIS Query Number _____ Date Released _____

Unclassified

Security Classification

**DOCUMENT CONTROL DATA - R & D**

*Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)*

1. ORIGINATING ACTIVITY (Corporate author)
Department of the Navy
David Taylor Model Basin
Washington, D.C. 20007

2a. REPORT SECURITY CLASSIFICATION
Unclassified

2b. GROUP

3. REPORT TITLE
NAVY AUTOMATED RESEARCH AND DEVELOPMENT INFORMATION SYSTEM (NARDIS) PROGRESS REPORT, JULY 1966

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)
Progress Report (1 June 1966 - 1 June 1967)

5. AUTHOR(S) (First name, middle initial, last name)
Gilbert R. Gray, Thomas A. Duckenfield, Joseph L. Fuchs

6. REPORT DATE
August 1966

7a. TOTAL NO. OF PAGES
36

7b. NO. OF REFS
None

8a. CONTRACT OR GRANT NO
R-F099 88 01

b. PROJECT NO.
880-601

c.

d.

9a. ORIGINATOR'S REPORT NUMBER(S)
2337

9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
None

10. DISTRIBUTION STATEMENT
Distribution of this document is unlimited.

11. SUPPLEMENTARY NOTES

12. SPONSORING MILITARY ACTIVITY
ONR (Code 403N)
Department of the Navy, Main Navy Bldg., Rm. 0439, Washington, D.C., 20360

13. ABSTRACT

This report is a summary of NARDIS (Navy Automated Research and Development Information System) operations for fiscal year 1966. More than 500 requests (amounting to nearly 800 queries) were processed, the R&D data bank was doubled; and new responsibilities were assigned.

DD FORM 1 NOV 65 1473 (PAGE 1)

S/N 0101-807-6801

Unclassified

Security Classification

| 14 KEY WORDS | LINK A | | LINK B | | LINK C | |
|---|---|---|---|---|---|---|
| | ROLE | WT | ROLE | WT | ROLE | WT |
| Automation | | | | | | |
| Computers | | | | | | |
| Documentation | | | | | | |
| NARDIS | | | | | | |
| Naval Research | | | | | | |
| Information Storage | | | | | | |
| Information Retrieval | | | | | | |
| Progress Report | | | | | | |